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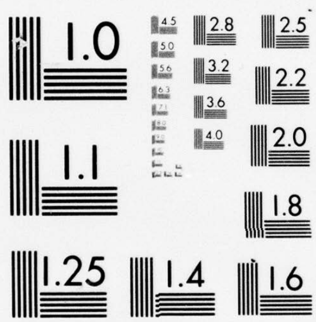

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REVIEW OF THE APPLICATION OF THE O&S COST MODEL TO THE A-10 PROGRAM CONTRACTOR INCENTIVE AWARD FEE

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OCTOBER 1977

FINAL REPORT

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DEAN OF THE FACULTY

UNITED STATES AIR FORCE ACADEMY

COLORADO 80840

Editorial Review by Lt Col Elser and Major Donovan
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This research report is presented as a competent treatment of the subject, worthy of publication. The United States Air Force Academy vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the author.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A final review of the application of the O&S Cost Model to the A-10 Program Contractor Incentive Award Fee was undertaken at the request of Brig Gen Rutter, Vice-Commander of the AFALD. A research proposal was developed by the Business Research Management Center at Wright-Patterson AFB, Ohio, to address four basic areas: (1) Describe the background and implementation of the O&S Cost Model as applied to the A-10 program, (2) Provide a critical analysis of the technique involved, (3) Identify the positive effects of the A-10 O&S Cost Model application, (4) Provide a summary of the lessons learned.

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I. INTRODUCTION

Recently in Air Force weapons system acquisitions, great emphasis has been placed on consideration of the life cycle cost of the aircraft in contrast to past major emphasis on acquisition cost alone. That is, not only is there consideration of the aircraft's initial purchase price, but the Air Force is also closely examining the costs of flying and maintaining the aircraft over its lifetime. These long-term costs are known as operation and support (O&S) costs.

In the Air Force A-10 program, tremendous efforts have been made to minimize A-10 O&S costs, with great success. The foundation of these efforts is the application of the O&S Cost Model to the entire A-10 program. This model serves as the basis for the Contractor Incentive Award Fee Plan, which is intended to provide incentive to the contractor to design and produce an aircraft having low O&S costs, without sacrificing the aircraft's performance.

The O&S Cost Model was applied in the A-10 program only to serve as a means of comparison between the contractor's estimates of the A-10's O&S costs and the Government measurements of these costs. The O&S Cost Model is not intended to provide a complete, accurate dollar value for aircraft's lifetime O&S costs; its usefulness lies in its application to the Contractor Incentive Award Fee concept.

This study effort was limited to addressing four primary areas: (1) Describe the background and implementation of the O&S Cost Model as applied to the A-10 program, (2) Provide a critical analysis of the technique involved in the model's application, (3) Identify the positive effects of the A-10's O&S Cost Model application, (4) Provide a summary of the lessons learned.

The study approach included a review of the A-10 program history and progress to date, familiarization with the O&S Cost Model and the application of its equations, and discussions with Fairchild-Republic Corporation, General Electric Corporation, and A-10 System Program Office personnel.

Appropriate supporting material for this study has been included in the appendices.

II. Background and Implementation

The A-10 program used an award fee as an incentive to the prime contractors, Fairchild-Republic (FRC) and General Electric (GE), to produce an aircraft that has lower O&S costs. The $3.5 million fee provides for a maximum of $2.9 million awarded to FRC and $600,000 to GE. To determine the actual fee, two separate methods of evaluation were used: an objective portion based on an existent USAF O&S cost model, and a subjective evaluation made by the Government parties involved in the program. A combination of the subjective and objective evaluation results were presented to the Fee Evaluation Board as a basis for determining the amount of award fee for each contractor.

The AFLC O&S cost model was the basis for the objective evaluation of the contractors' success in reducing O&S costs for the A-10. The AFLC O&S model was an adaptation of a Life Cycle Costing (LCC) model developed by project ABLE (Acquisition Based on Logistics Effects). The purpose of the O&S model is two-fold: estimate the logistics support costs between the design proposals of two or more competing contractors and serve as a decision tool when choosing among design alternatives during prototyping for full-scale development (FSD). In the A-10 program, the O&S model had three uses; the cost model estimates figured in source selection for the FSD contract, evaluation of engineering change proposals (ECP) with respect to their impact on O&S costs, and as the basis for the objective portion of the award fee. The O&S model was adapted from its original purpose to the three uses required by the A-10 program.

The O&S model is an accounting model. Accounting models compute O&S cost estimates by using a set of equations to aggregate components of support costs. This O&S model uses reliability and maintainability characteristics such as mean time between removal (MTBR). The model computes O&S costs at low levels of hardware breakdown and disassembly (for example, line replacable units -- LRU's); then, these sub-costs are summed to estimate the particular O&S costs for the entire system. The set of thirteen equations models O&S costs in eight major areas: spare parts, maintenance, inventory management, Aerospace Ground Equipment (AGE), operational data, maintenance training, fuel, and engine maintenance and spares. The equations use program constants, contractor- and government-furnished data, and government-furnished constants as inputs. Necessary data for the model comes from AFLC 66-1 data compiled at quarterly intervals as part of the routine Air Force

K051 computer runs. The first four equations (spares, "off-equipment" LRU maintenance, "on-equipment" maintenance of all systems, and ineffective "off-equipment" maintenance) absorb more than three quarters of all data requirements; data for the other nine equations is collected from numerous contractor and Government sources. The original O&S model contained only ten equations: three equations were added to estimate costs of Spare Whole Engines and Modules for base pipelines, "off-equipment" maintenance for Whole Engines and Modules, and Spare Whole Engines, and Modules for depot pipelines. Although the final A-10 design did not incorporate a modular engine, these three engine equations are valuable for tracking engine O&S costs. A copy of the complete A-10 O&S model is attached as an appendix.

The objective portion of the award fee evaluation, supplied by the ten-year O&S cost model, consumed most of the A-10 program's LCC emphasis during the early phases of the design development. After release of the initial model and receipt of contractor-inspired recommendations for model improvements, the two competitive prototype phase (CPP) contractors, FRC and Northrup, submitted their logistics effects proposals as part of their design proposals. Since only Fairchild was selected as the FSD contractor, the model implementation with respect to the FRC proposal is discussed. In November of 1972, FRC submitted their thirteen TLE's (Target Logistics Effects). FRC computed their TLE's in accordance with the guidelines established by the Government-prepared model and obtained their results by applying program constants, Government-furnished values, and historical comparisons from other weapons systems. By comparing A-10 subsystems to similar systems in current Air Force inventory aircraft, FRC produced estimates of unit price, MTBR, condemnation rates, etc., which were then substituted into the model equations to produce the TLE's. FRC expended considerable manpower and effort to produce and document their TLE's because no USAF data base with inputs suitable to use in an O&S estimate existed before the A-10 program began. Without suitable historical USAF experience on previous aircraft, FRC had to reduce raw data on aircraft logistics and research other mature weapons systems.

TLE's are the baseline against which the contractor is compared for determination of the objective portion of the

award fee. To insure that realistic and stringent TLE's were submitted, the contractors submitted their O&S proposals during competition for the FSD contract. In addition to the competitive comparison of Northrup and FRC TLE's, both contractors knew that projected O&S costs were part of the source selection decision criteria. It would not be possible for the Government or a third party to establish realistic TLE's for the contractors because only they know the capabilities and limitations of their design proposals. By requiring TLE's during competition for the FSD contract and establishing projected logistics effects for source selection, the Government assured itself of complete and accurate TLE's for a realistic evaluation of objective results in the incentive award fee.

Measured Logistics Effects (MLE's) are the actual values based on operational data which are compared to the contractor's TLE's. During the logistics validation phase, which considers only operational flying hours, actual AFLC data reported from the quarterly K051 runs is used in the thirteen O&S cost model equations to produce the thirteen MLE's. MLE's are exactly analogous to TLE's, except that MLE's use operational data instead of estimates based on historical experience as in TLE's. At the end of each quarter, upon request, quarterly K051 data automatically feeds into the O&S cost model computer program. This program produces both a quarterly MLE across all systems and a cumulative MLE for the first four MLE equations: initial and replenishment spares, "on-equipment" maintenance, "off-equipment" maintenance, and ineffective "off-equipment" maintenance. The other nine MLE's are generated by hand from AFLC- and contractor- furnished data; usually, the contractor furnishes measurements of logistics effects which are then verified by the Government.

During the period between submission of the FRC TLE's and the end of the logistics validationphase, the original TLE's were modified by the Government to reflect configuration changes. Each engineering change proposal (ECP) submitted by the contractor included the contractor's assessment of the ECP's impact on any or all of the thirteen TLE's. This assessment included a total O&S dollar impact figure; but, more importantly, it contained all the proposed values affected by the ECP, such as MTBR, UP, etc. With these new values and the appropriate equation, the Government could validate the contractor's O&S cost impact

figure. During the course of the program, some ECP's were rejected because their O&S cost impact was too great. Disputes about the contractor-furnished values, like MTBR, involved in the ECP were solved by direct communication with engineering and cost analysts of the contractor. The final ECP O&S cost impact figure was the result of contractor analysis, Government validation, and negotiation of disputed assessments.

At the end of the logistics validation phase, the Government adjusted the contractors' TLE's to account for differences in the predicted growth values associated with maintenance. For TLE 1 through 4 (spares, "on- and off-equipment" maintenance, and ineffective "off-equipment" maintenance), growth curves relating to maintenance manhours were agreed upon earlier in the program; because of increased education and experience, the number of maintenance manhours required to perform maintenance would decrease over the lifetime of the aircraft. Costs associated with maintenance manhours would, therefore, decrease with decreasing maintenance manhours. To calculate the effects of growth curve maturity, the original agreement proposed a validation period during a specified timeframe (expressed in cumulative flying hours) within the aircraft lifetime. However, the actual validation period occurred earlier in the aircraft life, due to Congressional actions which reduced RDT&E aircraft and flying hours and activated the first operational wing earlier than predicted. So, with maintenance manhours decreasing against increasing cumulative flying hours, the earlier validation period resulted in increased maintenance manhours and increased costs in predicted O&S. The adjustments for lack of maturity along the growth curve produced higher TLE's. TLE's for the engine equations were not adjusted because the agreed upon engine growth factor was one.

Although the O&S cost model uses existing AFLC data systems to generate its variables, several data problems arose in MLE data collection during the logistics validation phase. For example, at the end of the logistics validation phase, two-thirds of all unit prices (UP) necessary for calculation of MLE 1 through 4 had not yet transferred into the automated data system. Therefore, UP's for all those items had to be manually loaded before a final cumulative MLE run could be made. Second, depot maintenance data necessary for calculation of MLE2 was not available. Because of depot repair reporting procedures, depot maintenance

manhours are not accurately recorded. So, depot maintenance manhours were estimated or approximated from other sources. As previously stated, significant data requirements exist only for MLE 1 through 4; any data problems involved calculations for these four measurements. Estimates and approximations for all gaps in the data, like UP and DMMH, came from engineering and cost analysis sources within the Government and the contractor. Overall, the cost model data requirements fit USAF data systems well - all gaps in the data necessary for the final run were filled manually in less than a week.

III. Critical Analysis of Technique

Following is an analysis of several aspects of the O&S Cost Model award fee application. This discussion should be of particular interest to those intending to apply this method in future weapons system acquistions.

1. MLE Equations: Any simplification of a model that can be accomplished without sacrificing its reliability or validity, will make its application easier. In an attempt to simplify this O&S cost model, we recommend that MLE4 and MLE12 both be included as part of MLE2. MLE2 is the equation for Off-Equipment Maintenance, MLE4 concerns Ineffective Off-Equipment Maintenance (maintenance done on an LRU at the base level before determining that it cannot be repaired and must be sent to the depot level), and MLE12 is the equation for Engine Off-Equipment Maintenance. A relatively constant percentage of all Off-Equipment Maintenance performed on a weapon system will be ineffective, so take that percentage of maintenance costs and add it to the result of MLE2. That will eliminate the need for MLE4. Concerning MLE12, there is no reason to separate Off-Equipment Maintenance performed on the engines from that performed on the rest of the aircraft. Include the engine-maintenance data as part of the data used for MLE2, and eliminate MLE12.

MLE11 and MLE13 concern spare engine supplies at the base and depot level. These MLE's should be altered from their present form (involving pipeline and safety stock amounts) to exactly correspond to AFLC's method of spares-buying.

With these adjustments to the model, it should be easier to understand and the data more easily managed. Any expansions to include more variables or new equations may increase its complexity beyond effective use.

2. LRU's: For a given model to be effective, there must be complete understanding between the contractor and the Government of the terms and variables of the model. One term in particular, "LRU", seems to cause problems in this area. A Line Replaceable Unit (LRU) can be anything from a single bolt in the wing structure to an entire radar unit, depending on the interpretation of the term. There is a means of preventing this problem. Let the contractor obtain his TLE's by using LRU's, as long as he accounts for the entire aircraft. The Government will compute its

MLE's on a Work Unit Code basis. Since the final value is the real concern here, it makes no difference that the means of arriving at the value were not the same. The important point is that both the LRU method and the Work Unit Code method must account for the entire weapons system.

3. Correction Factor: When this O&S cost model is first introduced in a specific acquisition program, there are many unforeseeable changes that will alter the results of the MLE equations. Two examples of these changes in the A-10 program are Aircraft Configuration Changes and Maintenance Concept changes. Although their effects may be negligible when taken individually, the aggregate effect of these changes can be significant. To offset this, we recommend that a correction factor, to the benefit of the contractor, be incorporated into the model (possibly at the end of the On-Equipment section).

4. Work Unit Codes: The maintenance data that drives this model is recorded at the base level by the individual performing the actual maintenance. He logs a maintenance job against a particular Work Unit Code. Problems arise here because there is room for interpretation concerning which WUC a given job will be recorded against. For example, one maintenance man repairing a brake assembly may record his job against the Landing Gear Unit WUC, while another man, performing the same job, will record it against the Brake Unit WUC. The solution here, of course, is to implement a recording system that allows for no interpretation. Specifically, match the individual parts in the Illustrated Parts Manual, one-for-one, to particular WUC's. This solution, however, is more easily recommended than accomplished.

5. Model Emphasis: The name given to this model may be misleading. Because it is called the Ten-Year O&S Cost Model, it is often taken to be a means of arriving at an exact dollar value for O&S costs over a ten-year period for the A-10. This model is not designed to be used as a predictor of total ten-year O&S costs for any given weapons system. Its purpose in this application is to serve as a basis for comparison between TLE's and MLE's in determining the contractor incentive award fee. Since some TLE's and MLE's consider ten-year costs, and others only consider costs incurred in the early phases of the program, calling the entire model a Ten-Year O&S Cost Model is inaccurate.

6. Evaluation Sequence and Time Frame: The overall concept of evaluation used in the incentive award fee application for the A-10 is sound. The three-component approach involving the subjective evaluation, objective evaluation, and Fee Evaluation Board appears complete; however, several areas can be strengthened. Many people involved with the A-10 program feel that the incentive fee is awarded too late (after the design phase) to be effective. We recommend that the Air Force engineers evaluate the contractor's engineering design based on O&S considerations at the Critical Design Review (CDR) and immediately award an incentive fee. This fee should be separate from the final award fee.

The subjective portion should be implemented when the full production contract is awarded and should continue until the first training squadron becomes active. It is during this period that most of the actual planning and coordinating for production takes place.

The data for the objective portion should be run through the O&S Cost Model equations beginning the first quarter after the first training squadron becomes active and should be run quarterly until 10,000 hours of flying time has been accumulated. This 10,000 hour mark was chosen because of numerous complications that developed with the 5,000 hour timeframe.

The 5,000 hour timeframe is inadequate for several reasons. By the time 5,000 hours of flying time has been accumulated on the airframe, many of the LRU prices are still not available. The data itself is incomplete at this point because it lacks information on removal rates of numerous LRU's. Some LRU's are just not removed before 5,000 hours. Also, the majority of the 5,000 hour data was taken from the training environment, causing it to be biased. An example of this bias is the increased tire failure rate due to practice landings.

The 10,000 hour mark should allow enough time for the contractors to provide all the LRU unit prices, as well as give more complete data on LRU removal rates. Also, 10,000 hours should include a large enough amount of operational data to alleviate the effects of the training scenario bias. Note, here, that because of the difficulty and effort involved, we recommend that separation of training from operational data not be attempted.

IV. Positive Effects of the O&S Model

1. Contractor awareness of long-range logistics cost implications has increased.

2. Needed experience has been gained through an understanding of the problems encountered in using a standard, Government-supplied O&S Cost Model.

3. Government review of contractor ECP's has been done with consideration of the O&S costs involved.

4. Improved SPO-contractor relations have resulted from the incentive fee tied to the O&S Cost Model.

5. This O&S Cost Model application has led to other uses of the model. For example, Jack Bussio in the Reliability Engineering Section of the Sacramento ALC applies the model to several individual electronics subsystems, in the same way that it was used with the A-10.

6. The Life Cycle Cost of the A-10 may have been reduced by the application of the model; however, it is impossible to determine this for sure. There is no control group with which to match the present A-10 costs, but comparison to other existing weapons systems shows that the A-10 O&S costs are significantly lower.

Other indicators show that the A-10 has a high OR rate and a low NORs rate in comparison to other current Air Force inventory aircraft. The vast majority of the people interviewed in the A-10 SPO feel that the O&S Cost Model has had a very positive effect in terms of minimizing the A-10's Life Cycle Cost. And finally, without exception, the contractors' comments were positive in support of O&S cost considerations in future weapons system acquisitions.

V. Model Limitations

1. The O&S Cost Model has no "built-in" capability to deal with program changes for which the contractor is not responsible. Changes in maintenance concept, configuration, and operational usage are not initiated by the contractor, yet his TLE's are still measured against Government MLE's that include these changes. For example, fuel costs increased significantly due to an Air Force decision to increase the aircraft time at full military power, but the contractor's TLE's were not adjusted. To offset this, the situation is considered in the subjective portion of the contractor evaluation.

2. Problems exist with data acquisition early in the program. For example, two-thirds of the unit prices for A-10 parts were unavailable when needed. Due to a lack of accurate USAF data, much of the Depot Maintenance Manhour (DMMH) data was also unavailable. In addition, much of the data reduction requires actual manhandling of the data. An example is the adjustment of the TLE's for growth curves. Finally, data will vary from base to base early in the model's application due to differences in usage, i.e., training versus operational.

3. The O&S Cost Model is incapable, at this point, of predicting total O&S costs. It is a predictor only of those costs which are sensitive to engineering design. All other O&S costs are not included.

VI. Lessons Learned

This section highlights the major finding of this study. Included are recommendations of how to address many of the problem areas in the O&S Cost Model's application, as well as miscellaneous items of informational value. It is anticipated that cognizance of these points will provide guidance on how better to apply the O&S Cost Model in the future.

1. With regard to contractor's ECP's, when the contractor proposes an engineering change which will reduce O&S costs, we recommend that his TLE's not be adjusted downward. If the contractor is making successful efforts to minimize the O&S costs for the weapons system, why should he be penalized by making the targets harder to reach through ECP adjustments?

2. In its present state, the O&S Cost Model is at its most effective level of complexity. We recommend that more variables not be introduced and the number of equations not be increased.

3. It is an effective practice to have the TLE's be contractor-generated during the Competitive Prototype Phase of weapons systems acquisition. Using the TLE as a criteria for source selection forces competition, which leads to lower TLE's.

4. The total TLE estimate should include an additive miscellaneous correction factor, to the benefit of the contractor, to allow for changes in the program beyond the contractors' control. Examples: Air Force maintenance concept changes and changes in operational usage.

5. We recommend that data on all the LRU's be tracked, but do not attempt to track configuration changes within LRU's.

6. To simplify the model and increase its efficiency, incorporate MLE4 and MLE12 into MLE2, and correct MLE11 and MLE13 to more accurately reflect AFLC's data methods.

7. Quarterly data tapes on weapons systems are saved for only six months, unless otherwise ordered. Also, the O&S Cost Model computer program does not run automatically at the end of the quarterly K051 run. The O&S Cost Model computer run must be specifically requested. The last scheduled run occurred at the end of April 1977.

8. Almost 90% of the data required by the model pertains to MLE's 1 through 4. These are the only MLE's on the computer program. The other nine MLE's are either hand-calculations or verifications of contractor-submitted figures.

9. The entire evaluation process (objective, subjective, and Fee Evaluation Board) should be included in the RFP as well as the contract. Since 90-95% of O&S costs for a weapon system is already determined by the time the prototype is built, the sooner the emphasis on O&S considerations, the more beneficial will be the effects.

10. Concerning the subjective evaluation, the Government should take more of the responsibility for ensuring contractor response. Presently, the burden to respond to low subjective evaluations lies with the contractor; however, if contractor response means lower costs (as is usually the case) then the Government would benefit by ensuring that response.

11. To obtain LRU unit prices, contact the item's Air Force item manager at the depot level, who in turn will contact his counterpart in the contractor's organization. For Depot Maintenance Manhour data, use contractor estimates of required DMMH resulting from contractor/vendor repairs performed prior to the existence of depot repair capability.

12. We recommend that the grounds for the Incentive Award Fee be clarified. Is the achievement of the TLE sufficient for award of the majority of the fee, etc?

13. Conversion of all dollar values to a constant-year dollar figure is a time-consuming, involved process. A problem arises of which inflation factor to use.

14. Some of the TLE's must be adjusted according to estimated growth/learning curves to account for the position of the validation period within the lifetime of the aircraft.

15. Consecutive quarterly computer runs of the O&S Cost Model on data from mature weapon systems (A-7D, F4E) yields consistent MLE values. This implies that the model is consistent and predictable, and therefore, can be used to identify/analyze trends and problem areas.

16. There is an adjustment necessary to negate the duality in spares computations from MLE1 and MLE's 11 and 13. Engine spares should only be included once in the total TLE/MLE.

17. The majority of the contractor incentive fee should be awarded on the basis of the objective results from the model. The only real measure of O&S costs lies in the reduction and analysis of operational flying data on the aircraft.

18. The 5,000 flying hour validation period for the O&S Cost Model MLE computations is not of sufficient length. To insure more complete data in future applications, we recommend that the validation period be extended to 10,000 flying hours on the airframe.

19. To provide a greater emphasis on O&S cost considerations before the prototype is built, we recommend that there be an award fee early in the program for engineering design, possibly at the Critical Design Review.

20. The value of the O&S Cost Model to systems acquisition appears to be quite high. Based on our experience, and the importance of effective model application, we recommend that one individual in the Integrated Logistics Support Division of a given System Program Office be assigned full-time to the implementation and management of the O&S Cost Model.

VII. SUMMARY

This study is a final review of the application of the O&S Cost Model to the A-10 Program Contractor Incentive Award Fee. The study includes: (1) A description of the background and implementation of the model, (2) A critical analysis of the technique involved, (3) An identification of the positive effects of the A-10 O&S Cost Model application, (4) A summary of the lessons learned.

The O&S Cost Model is an accounting model intended specifically to track long-term logistics costs that are sensitive to engineering design. The model is not capable of providing a dollar estimate of the total O&S costs for a particular weapons system. Its primary application is as a basis for the Contractor Incentive Award Fee Plan. In this plan, the model provides for a comparison between contractor TLE's and Government MLE's, and the results are used to determine the amount of the contractor incentive fee awarded.

Although the O&S Cost Model is presently a valuable technique, several areas can be strengthened. These include redundant MLE equations, term definitions, unforeseen program changes, data availabilty and accessibility, and evaluation sequence and timeframe. This report identifies these problem areas and, in many instances, recommends ways to deal with them.

Experience with the O&S Cost Model indicates that it is an effective means of minimizing weapons system O&S costs. Although the effectiveness cannot be quantified, it is the opinion of those most familiar with the model that its application was instrumental in reducing the life cycle cost of the A-10, and most feel that the O&S Cost Model should be an integral part of future weapons system acquisition programs.

APPENDIX A

A-10 O&S Cost Model Chronology

A-10 O&S COST MODEL CHRONOLOGY

DATE	PROGRAM EVENT
May 1970	Release of Competitive Prototype Phase (CPP) RFP to Industry. RFP advises that 10-year O&S cost estimates will be part of criteria in full-scale development (FSD) source selection.
Jun 1970	Preliminary O&S cost model released to bidders.
Dec 1970	Selection of Fairchild-Republic and Northrop Corporation as CPP contractors.
Mar 1971	Receipt of contractor recommendations for model improvements.
Sep 1972	FSD RFP O&S Cost Model finalized and included in RFP and statement of work.
May 1972-Jun 1975	FSD contractor test period with prototype aircraft.
May-Oct 1972	Competitive Flyoff (contractor).
Nov-Dec 1972	Competitive Flyoff (Government).
Nov 1972	CPP contractors submit 10-year O&S cost index estimates (target logistics effects) and Government assesses their credibility.
Jan 1973	Selection of Fairchild-Republic as FSD contractor. Target logistics effects considered in choice of FSD contractor.
Mar 1973	FSD contract awarded.
Mar 1973-Mar 1974	FSD Contractor design-trade activities to reduce O&S costs.

May 1974	Critical design review.
Jul 1974	Initial production decision.
Jul 1974-	Production.
Feb 1975-Sep 1977 (Projected)	FSD Government Developer test period.
Feb 1976	Full production decision.
Mar 1976-Mar 1977	FSD user test period with OT&E continuing throughout life of aircraft.
Mar 1977	Davis-Monthan AFB Wing activated.
Apr 1977	End of Logistics Validation Period. 5287 operational flying hours from 1 Apr 1976 through 30 Apr 1977.
May 1977	Nellis AFB wing activated.
Jun-Jul 1977	Final data reduction for O&S model based on 5287 operational flying hours. Final computations of cumulative and quarterly data from Mar 1976 through Apr 1977. Completion of subjective evaluations from directorates, Sacramento ALC, and San Antonio ALC. Final adjustment to target logistics effects.
Jul 1977	Myrtle Beach AFB wing activated.
Jul 1977	Final briefings to General Electric and Fairchild-Republic on results of O&S cost model measurements.
Jul 1977	Award fee briefing to fee board in Washington.
Jul 1977	Fee awarded.

APPENDIX B

Required Contacts to Apply the O&S Cost Model

Required Contacts to Apply the O&S Cost Model

Each weapons systems O&S Cost Model application is unique and will have its own data requirements. However, in future applications of the O&S Cost Model the aid and efforts of the following groups will be instrumental.

1. For any assistance in incorporating the O&S Cost Model into a contract, RFP, etc., contact the Reliability Engineering Section at the Sacramento ALC; their office symbol is SM-ALC/MMEA, autovon 633-2865. The Reliability Engineering Section is part of the Materials Analysis Branch of the Engineering Division.

2. To obtain computer assistance for the O&S Cost Model on a particular weapons system, contact the Sacramento ALC Comptroller Unit; their office symbol is SM-ALC/ACDC, autovon 633-4161.

APPENDIX C

O&S Cost Model Data Sources

Data Sources

1. AFLC 66-1 data: To obtain 66-1 data for input to the model, contact Eleanor Puckett in AFLC Headquarters, WPAFB, Ohio. Her office symbol is LOLMA, autovon 787-3435.

2. Contractor -- For data concerning a particular subsystem or LRU, contact the contractor, as well as the Air Force item manager for that item.

3. The User Commands -- Contact the appropriate commands as necessary, for questions will arise during the model's application that can be answered only by the using organization.

APPENDIX D

Operations and Support Cost Model

1.0 INTRODUCTION

This document defines the operation and support cost model which shall be used in the design and management tradeoff process and to compute the Target Logistics Effects as required by Paragraph 3.9 of the Integrated Logistics Support Program Plan, 160P09D413.

1.1 PROGRAM ASSUMPTIONS

The equations hereinafter set forth are built on the basis of the number of aircraft and war and peace utilization rates as set forth in the System Specification. For the purpose of exercising the tradeoff model, the contractor will assume one training base and five main bases. Each of the training bases will operate with single-wing-level intermediate maintenance capability. The operational bases will operate with independently deployable squadrons (24 U.E. aircraft per squadron). The ultimate intermediate maintenance capability allocated to each squadron shall be consistent with the results of the Optimum Repair Level Analysis (ORLA) carried out in accordance with Paragraph 5.3.4 of the SOW. The level of repair decisions for the purposes of this model shall be based on any preliminary ORLA performed, or, in the absence of such analysis, level of repair decisions consistent with that for equipment of similar form, fit, or function shall be acceptable. Notwithstanding the foregoing, all operational bases shall possess a single-wing-level intermediate maintenance capability for engine maintenance. Augmenting this, each separately deployable operational squadron shall be outfitted with the equipment and data necessary for removal and replacement of each separately identified engine module.

1.2 LOGISTIC EFFECTS EQUATIONS

The 10-year O&S cost model consists of 13 separate cost elements as follows: (1) Spares (both initial and replenishment spares for Line Replaceable Units (LRUs); (2) "Off-Equipment" Maintenance of LRUs; (3) "On-Equipment" Maintenance of all systems; (4) Ineffective "Off-Equipment Maintenance"; (5) New Item Inventory Management; (6) Acquisition of Aerospace Ground Equipment (AGE); (7) Acquisition of Training Equipment and its Ancillary Support AGE; (8) Acquisition Cost of Operational Phase Data; (9) Type I Training; (10) Fuel Consumption; (11) Spare Whole Engines and Modules for the ARBUT and base repair pipelines and base safety stock; (12) "Off-Equipment" maintenance for Whole Engines and Modules; (13) Spare Whole Engines and Modules for depot pipeline and depot safety stock.

Where an equation is the appropriate means for the computation of a cost elements, two forms of the equations are presented herein. In each case, the first form of the equation presented is configured for prediction and the second form of the equation presented is configured for measurement of the same element during a test and data collection period. The aggregate output of the predictive equations is referred to herein as "Target Logistic Effects" (TLE), and the aggregate output of the measurement equations is referred to herein as "Measured Logistic Effects" (MLE).

1.3 The value derived from exercising the TLE model shall be denoted "TLE" and shall be computed by summing the thirteen cost elements (TLE_j, j=1, 2..., 13) definitized below. Symbolically,

$$TLE = \sum_{j=1}^{13} TLE_j$$

The TLE model shall be used by the contractor to compute a TLE for validation Period II (TLE_I) and a TLE forecast for CY 77 (TLE_{II}), the only difference being in the value of the input parameters.

1.4 The value derived from exercising the MLE model shall be denoted "MLE" and shall be computed by summing the thirteen cost elements (MLE_j, j=1, 2..., 13) definitized below. Symbolically,

$$MLE = \sum_{j=1}^{13} MLE_j$$

The MLE model shall be used by the government to compute both MLE_I and MLE_{II}, the only difference being in the value of the input parameters.

1.5 In the cost elements which follow, the term Line Replaceable Unit (LRU) shall have reference to those components of a system which are designated for removal when they malfunction and are replaced with a like unit by the operating squadron personnel performing on-equipment maintenance on board the aircraft or on the flight line. The malfunctioning LRUs are subsequently repaired or condemned by a local shop or a specialized repair activity. In this context repair parts used in on-equipment maintenance and repair parts or reparable components used in off-equipment maintenance are not LRUs. All LRUs of all subsystems of the A-10

weapon system shall be included. Major engine modules (e.g., fan turbine) shall not be counted as LRUs, but shall be considered separately in the engine equations.

In the equations which follow, the individual line item parameters in the TLE equations will have the symbol "#" as a superscript. Such a superscript on a parameter shall indicate the contractor's estimate of the value that parameter will take on later in the corresponding MLE formula (that is, as measured in the TLE validation test period). Except for a few special cases, definitions for only the unsuperscripted parameters will be explicitly given below.

The data collected during the validation periods on individual LRUs shall be indexed by Manufacturer's Part Number and associated stock number (where available).

1.6 The first element of cost to be considered shall be the dollars associated with the spare quantities of all LRUs over all subsystems, which must be initially acquired and/or subsequently replaced over the operational life cycle to keep the base and depot pipelines sufficiently stocked to meet established support objectives. *This cost element shall be computed in accordance with the following formula:*

$$TLE_1 = \sum_{i=1}^{N^{\#}} \left[\frac{(MFFH)\,(QPA^{\#}{}_i)}{MTBR^{\#}{}_i} \right] (UP^{\#}{}_i) \left[1/3\ (RTS^{\#}{}_i) + 3\ (NRTS^{\#}{}_i) \right] +$$

$$\sum_{i=1}^{N^{\#}} \left[\frac{(PFFH)\,(QPA^{\#}{}_i)}{MTBR^{\#}{}_i} \right] \left[(UP^{\#}{}_i)\quad (COND^{\#}{}_i) \right]$$

The MLE analogue for this cost element is as follows:

$$MLE_1 = \sum_{i=1}^{N} \left[\frac{(MFFH)\ (TR_i)}{TFH} \right] (UP_i) \left[1/3\ (RTS_i) + 3\ (NRTS_i) \right] +$$

$$\sum_{i=1}^{N} \left[\frac{(PFFH)\ (QPA_i)}{MTBR_i} \right] \left[(UP_i)\ (COND_i) \right]$$

where

N	= the number of separately identifiable CFE and GFE LRUs of the A-10 aircraft used in the test period.
UP_i	= the validated unit price of the i^{th} LRU. That is, the price exhibited for the initial provisioning of the i^{th} LRU.
TR_i	= the number of removals of the i^{th} LRU over the total number of test aircraft during the TLE validation test period.
TFH	= the total number of flying hours completed by all test aircraft during the TLE validation test period in accordance with the approved and negotiated test plan.
RTS_i	= the decimal fraction of removals of the i^{th} LRU during the TLE validation test period which are ultimately returned to service by intermediate-level maintenance without having had any depot-level maintenance work done on the item. *
$NRTS_i$	= the decimal fraction of removals of the i^{th} LRU during the TLE validation test period which are ultimately returned to service by depot-level maintenance.
$COND_i$	= the decimal fraction of removals of the i^{th} LRU during the TLE validation test period which are condemned at any level of maintenance. If repair is attempted at any or several levels of maintenance only to be condemned and not returned to serviceable condition, such an action shall be considered a "COND" action but not a "RTS" or "NRTS" action even though the item may have passed through intermediate or depot-level maintenance. Condemnation for a reparable item occurs as the result of a failure which is of such a nature that repair is either technically or economically infeasible as determined in accordance with the criteria set forth in AFLCM/AFSCM 800-4, dated 25 June 1971. For an item recommended by the contractor as non-reparable, all removals of the system shall be construed to result in condemnation. *
MFFH	= expected peak total force flying hours/month = 48,960 hours/month.

PFFH = the programmed total force life cycle flying hours (peace program) = 2,423,520 flying hours.

$QPA^{\#}_i$ = the maximum number of a given i^{th} LRU expected to be installed on any A-10 aircraft in the TLE validation test.

$MTBR^{\#}_i$ = expected mean time between removals of the i^{th} LRU during the TLE validation test, measured in units of flying hours, where all removals except those accomplished to obtain access to other elements of the system shall be counted.

*When the exigencies of the test program dictate the necessity for repair or overhaul of an item at other than the level of maintenance where it would normally be repaired, or when an item that would normally be condemned is repaired, costs shall be counted for the normal action rather than the action taken to satisfy the emergency situation.

1.7 The next element of cost to be considered is the dollars associated with the "off-equipment" maintenance of LRUs removed from the total force of aircraft over the life cycle. This cost element shall be computed in accordance with the following formula:

$$TLE_2 = \sum_{i=1}^{N^{\#}} \left[\frac{(PFFH)\,(QPA^{\#}_i)}{MTBR^{\#}_i} \right] (UP^{\#}_i) \left[(NRTS^{\#}_i)\,(DRP^{\#}_i) + (RTS^{\#}_i)(BRP^{\#}_i) \right]$$

The MLE analogue for this cost element is as follows:

$$MLE_2 = \sum_{i=1}^{N} \left[\frac{(TR_i)(PFFH)}{TFH} \right] (UP_i) \left[(RTS_i)(BRP_i) + (NRTS_i)(DRP_i) \right]$$

where

DRP_i = the validated ratio of the average cost to repair the i^{th} LRU utilizing depot-level maintenance procedures to its validated unit price (UP_i). This element of cost shall be computed on all LRU's denoted i removed during the TLE validation test period. Even if the flying for test period has ended, all repairs resulting from removals during the test period shall be costed out and be a part of this cost element. DRP_i shall be computed as follows:

$$DRP_i = \frac{(DMMH_i)(DLR)}{(TR_i)(NRTS_i)(UP_i)} + \frac{RTT_i}{UP_i}$$

where

$DMMH_i$ = the depot-level maintenance manhours expended on all items denoted i removed during the TLE validation test period.

DLR = depot-level labor rate for the purpose of this computation = \$17/hour. This rate includes the expected cost of consumable materials used in the repair process.

RTT_i = total round trip transportation costs expended on item i resulting from deficiencies generated in the TLE validation test period. RTT_i shall be computed as follows:

$$RTT_i = (2)(WT_i)(CPP)$$

where

WT_i = weight in pounds of LRU i.

CPP = cost per pound for packaging and shipping equals \$.49.

The cost of both direct and indirect labor and of the average consumables expended in repair actions is included in the DLR factor.

BRP_i = the validated ratio of the average cost to repair the i^{th} LRU using intermediate-level maintenance procedures to its validated unit price (UP_i).

This element of cost shall be computed over all LRUs denoted i removed during the TLE validation test period (even if the actual repair occurs after the test flying hours have been completed).

BRP_i shall be computed as follows:

$$BRP_i = \sum_{j=1}^{NSL} \frac{\left[(BMMH_{ji})\ (BLR_j)\right]}{(TR_i)(RTS_i)(UP_i)}$$

where

NSL = the total number of different skill levels utilized in Air Force repair operations at the organizational and intermediate level = 3.

$BMMH_{ji}$ = the number of intermediate-level maintenance manhours expended by skill level j on all items denoted i removed during the TLE validation test period.

BLR_j = base labor rate (including salary, fringe benefits, overhead, lost time, and consumable material) for skill level j as follows:

Skill Level	$\underline{BLR_j}$	Symbol
E-3	\$11/hr	BLR_1
E-5	\$13/hr	BLR_2
E-7	\$15/hr	BLR_3

Other variables are as previously defined.

The criteria for condemnations and for sending removed items to the various levels of maintenance shall depend on the mode and extent of failure as definitized in the approved ORLA recommendations.

1.8 The next element of cost to be considered consists of the dollars associated with "on-equipment" maintenance that the Government may expect to utilize incident to servicing, preventive maintenance unscheduled maintenance and scheduled or unscheduled removals or replacements on the total force of aircraft over the life cycle. This cost element shall be computed as follows:

$$TLE_3 = (PFFH) \sum_{j=1}^{NSL} (MMH^{\#}_j)(OLR_j)$$

The MLE analogue for this cost element is as follows:

$$MLE_3 = (PFFH) \sum_{j=1}^{NSL} (MMH_j)(OLR_j)$$

where

OLR_j = organizational labor rate (including salary, fringe benefits, overhead, lost time and consumable material) as follows:

Skill Level	$\underline{BLR_j}$	Symbol
E-3	\$10/hr	OLR_1
E-5	\$12/hr	OLR_2
E-7	\$14/hr	OLR_3

MMH_j = the validated "on-equipment" maintenance manhours per flying hour expended on the entire A-10 weapon system by skill level j in the categories of (a) servicing, (b) preventive maintenance, (c) unscheduled maintenance, and (d) scheduled or unscheduled removals and replacements as a result of deficiencies generated during the TLE validation test period. This data will be collected by

three-digit Work Unit Code (WUC). MMH_j shall be computed as follows:

$$MMH_j = \frac{OMMH_j}{TFH}$$

where

$OMMH_j$ = the validated "on-equipment maintenance manhours expended in categories (a) through (d) above by skill level j on deficiencies of the A-10 weapon system generated during the TLE validation period.

Other variables are as previously defined.

1.9 The next element of cost to be considered is the dollars associated with ineffective intermediate-level maintenance actions over the A-10 life cycle. This element of cost shall be computed in accordance with the following formula:

$$TLE_4 = (PFFH) \sum_{j=1}^{NSL} \left[(IBMMH^{\#}_j)\,(BLR_j) \right]$$

The MLE analogue for this cost element is as follows:

$$MLE_4 = (PFFH) \sum_{j=1}^{NSL} \left[(IBMMH_j)\,(BLR_j) \right]$$

where

IBMMH = the ineffective maintenance manhours per flying hour expended by skill level j at intermediate level on all removals from all subsystems of the A-10 resulting from the TLE validation test period. The manhours in question here are those expended prior to a maintenance attempt being specified by any of the following Action Taken Codes: C, D, 1, 2, 3, 4, 5, 6, 7, 8, or 9. $IBMMH_j$ shall be computed by accumulating the actual maintenance manhours as described above and dividing by TFH.

Other symbols are as previously defined.

1.10 The next element of cost to be considered is the new item inventory life cycle management cost expected to accrue to the Government, based on the number of new "P" coded items which the contractor recommends and the Government approves. A "P" coded item shall be as defined in DOD "Guide to Life Cycle Costing, LCC-1, July 1971. This cost element shall be computed in accordance with the following model:

$TLE_5 = (NP^{\#})\quad(\$1,030)$

The MLE analogue for this cost element is as follows:

$MLE_5 = (NP)\quad(\$1,030)$

where

NP = the number of new "P" coded items recommended by the contractor and approved for acquisition by the Government from the time the Full-Scale Development contract is awarded, until the completion of the respective TLE validation test period, plus the number of new "P" coded items subsequently designated under the instant contract.

1.11 The next four cost elements to be considered will have no formulae provided because each is a straightforward accounting exercise.

1.12 The next element of cost to be considered is the acquisition cost of peculiar Aerospace Ground Equipment (AGE) (except that accounted for in 1.13 below) for all levels of maintenance expected to accrue to the Government over life cycle. The contractor's estimate of the sum of all money spent or obligated by the Government for the purchase of peculiar AGE end items (connected with the A-10 weapon system) from the time the Full Scale Development contract is awarded until the completion of the respective TLE validation test period plus the costs which subsequently accrue under the given contract for peculiar AGE line items not priced and/or delivered by the end of the test period shall be denoted TLE_6. Any piece of AGE that must be designed and fabricated in support of the specific requirements of the A-10 shall be considered peculiar, i.e., contractor(s) furnished equipment not currently in the Government inventory. The actual costs generated in this category shall be denoted MLE_6.

1.13 The next element of cost to be considered is the acquisition cost of peculiar maintenance training equipment and its ancillary support AGE expected to accrue to the Government over life cycle. The contractor's estimate of all money spent or obligated by the Government for the purchase of such equipment (connected with the A-10 weapon system) from the time the Full Scale Development contract is awarded until the completion of the respective TLE validation test period, plus the costs which subsequently accrue under the given contract for peculiar maintenance training equipment line items not priced and/or delivered by the end of the test period shall be denoted TLE_7. The actual costs generated in this category shall be denoted MLE_7.

1.14 The next element of cost to be considered is the acquisition cost of operational phase data expected to accrue to the Government over life cycle, where data is any form of Air Force Technical Orders listed on a DD Form 1423. The concern here is with only that data relevant to the operational phase of the weapon life cycle. The contractor's estimate of the cost to the Government for all such technical data to be acquired through the acquisition contract shall be denoted TLE_8, and the actual costs generated in this category shall be denoted MLE_8.

1.15 The next element of cost to be considered is the cost expected to accrue to the Government as a result of Type I maintenance training associated with this weapon system acquisition. TLE_9 shall denote the contractor's estimate of the sum of all money spent or obligated by the Government on Type I maintenance training (in connection with the A-10 program) from the time the Full Scale Development contract is awarded until the end of the respective TLE validation test period. The actual costs generated in this category shall be denoted MLE_9.

1.16 *The next element of cost to be considered is the* fuel consumption costs expected to accrue over the life cycle. These cost elements shall be computed as follows:

$$TLE_{10} = \frac{(GFC\#)}{(TFH)} \quad (PFFH)(CGF)$$

$$MLE_{10} = \frac{(GFC)}{(TFH)} \quad (PFFH)(CGF)$$

where

GFC = gallons of fuel consumed during the TLE validation test period.

CGF = cost per gallon of fuel (includes transportation cost) = \$.11.

PFFH is as previously defined.

1.17 The next element of cost to be considered consists of the estimated dollars associated with the spare quantity of whole engines and engine modules which must be acquired to keep the Automatic Resupply and Buildup Time (ARBUT) and base repair pipelines and base safety stock sufficiently stocked to meet established support objectives. In the above context, spare engines include all engines except those furnished as installed items on delivered aircraft. Automatic Resupply and

Automatic Resupply and Buildup Time is explained in AFM 400-1, 5 January 1970. This cost shall be computed in accordance with the following model:

$$TLE_{11} = (CP^{\#})\,(LS)\;\; f\left(\frac{(RR^{\#})(BP)(FFH) + (1-RR^{\#})(AP)(FFH)}{(CMRI^{\#})(LS)}\right) \;+$$

$$(m)\left[\frac{FFH}{CMRI^{\#}}\right]\sum_{k=1}^{NM}\left[(UP_k^{\#})(MR_k^{\#})\right]\cdot\left[(RR_k^{\#})\,(BP_m) + (1-RR_k^{\#})\,(AP)\right]$$

The MLE analogue for this cost element is as follows:

$$MLE_{11} = (CP)(LS)\;\; f\left(\frac{(RR)\,(BP)\,(FFH) + (1-RR)\,(AP)\,(FFH)}{(CMRI)\;\;(LS)}\right) \;+$$

$$(m)\left[\frac{FFH}{CMRI}\right]\sum_{k=1}^{NM}\left[(UP_k)\;(MR_k)\right]\left[(RR_k)\;(BP_m) + (1-RR_k)\;(AP)\right]$$

where

CP = the contractual price per engine to the Government exhibited at the time of initial provisioning of the engine.

LS = the expected number of locations where spare engines and modules will be stocked = 10.

f = represents a function of the variable contained in the large parentheses as follows:

> f(X) = value read from column II of the safety level table (page 8-3, AFM 400-1, 5 January 1970) corresponding to the X value in column I. For example, if the value in the parentheses works out to be 3.5, the value in column II on page 8-3 of AFM 400-1 is read as 6 because 3.5 lies in the 3.19 - 3.93 interval.

AP = ARBUT pipeline standard for the A-10 engine and modules = 20 days.

FFH = expected peak total force engine flying hours/day = total programmed quantity of UE aircraft times number of installed engines per aircraft times expected peak flying hours (greater of war or peace program) per day per UE aircraft = 3264 hours/day.

RR = validated whole engine return rate for base maintenance, i.e., the decimal fraction of whole engine removals during the TLE validation test period which are ultimately returned to a serviceable condition by intermediate-level mainte-

nance (without undergoing any depot-level maintenance). If the engine undergoes any depot-level maintenance before being returned to serviceable condition, it shall be counted in the "1-RR" decimal fraction.

CMRI = mean time (measured in engine flying hours) between removals of whole engines during the TLE validation test period, counting removals for both intermediate and depot-level maintenance.

CMRI is computed as follows:

$$CMRI = \frac{ETFH}{ETR}$$

where

ETFH = the engine flying hours accrued during the TLE validation test period = (2)(TFH).

ETR = the number of whole engines removed during the TLE validation test period for which either intermediate or depot-level repair results.

$$m = \begin{cases} 1, \text{ if the engine is of modular construction} \\ 0, \text{ if the engine is not of modular construction} \end{cases}$$

$$BP_m = \begin{cases} 9, \text{ for } BP_1 \\ 14, BP_0 \end{cases}$$

NM = the number of separate major modules of the engine.

UP_k = the contractual price for the k^{th} module exhibited at the time of initial provisioning for the module.

MR_k = the decimal fraction of engine removals during the TLE validation period resulting in the replacement of module k.

RR_k = the validated decimal fraction of the removals of module k during the the TLE validation period which are ultimately returned to a serviceable condition by intermediate maintenance without any depot-level maintenance having been performed.

1.18 The next element of cost to be considered consists of the estimated dollars associated with the "off-equipment" repair (as defined in T.O. 00-20-2, 1 Jan 1970) of whole engines and modules removed from the total force of aircraft over its life cycle. This cost shall be computed in accordance with the following model:

$$TLE_{12} = \frac{(EFFH)\left[(RR^{\#})(EBRP^{\#}_{m}) + (1-RR^{\#})(EDRP^{\#})\right]}{(CMRI^{\#})} +$$

$$(m)\left[\frac{EFFH}{CMRI^{\#}}\right]\sum_{k=1}^{NM}(MR_k^{\#})\left[(RR_k^{\#})(MBRP_k^{\#}) + (1-RR_k^{\#})(MDRP_k^{\#})\right]$$

The MLE analogue for this cost element is as follows:

$$MLE_{12} = \frac{(EFFH)\left[(RR)(EBRP_{m}) + (1-RR)(EDRP)\right]}{(CMRI)} +$$

$$(m)\left[\frac{EFFH}{CMRI}\right]\sum_{k=1}^{NM}(MR_k)\left[(RR_k)(MBRP_k) + (1-RR_k)(MDRP_k)\right]$$

where

EFFH = the total number of engine flying hours programmed to be flown (peace program) over the life cycle of the A-10 = 4,847,040 hours.

$EBRP_1$ = demonstrated average cost of replacing major engine modules during the TLE validation test period.

$EBRP_0$ = validated average cost to repair a whole engine using intermediate-level maintenance procedures. This cost element shall be based on all whole engines so repaired which result from removals during the TLE validation test period. EBRP shall be computed as follows:

$$EBRP_0 = \sum_{j=1}^{NSL}\frac{(EBMMH_j)(BLRE_j) + ECBM}{(ETR)(RR)}$$

where

$EBMMH_j$ = the number of intermediate-level maintenance manhours expended by skill level j due to whole engine removals during the TLE validation test period. However, if the engine is sent to depot level maintenance before being returned to service, the intermediate-level maintenance manhours accrued shall be considered depot-level manhours for the purpose of this computation.

$BLRE_j$ = the base labor rate for engines for skill level j as follows:

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Skill Level	$BLRE_i$	Symbol
E-3	\$9/hr	$BLRE_1$
E-5	\$11/hr	$BLRE_2$
E-7	\$13/hr	$BLRE_3$

ECBM = the dollar value of consumable material utilized in the intermediate-level repair or removals of whole engines during the TLE validation test period. If the engine is sent to depot-level maintenance before being returned to service, this consumable material shall be considered to have been utilized at depot level for the purposes of this computation.

Other symbols are as previously defined.

EDRP = average cost to repair a whole engine using depot-level maintenance procedures. This cost element shall be based on all whole engines so repaired which result from removals during the TLE validation test period.

EDRP shall be computed as follows:

$$EDRP = \frac{(EDMMH)(DLRE) + ECDM}{(ETR)(1-RR)} + (2)(EWT)(\$3.32)$$

EDMMH = the number of the depot-level maintenance manhours expended due to whole engine removals resulting from the TLE validation test period.

DLRE = depot labor rate for engines and modules = \$15/hour

ECDM = the dollar value of consumable material utilized in the process of depot-level repair of those whole engine removals resulting from the TLE validation test period.

EWT = the packaged weight of the A-10 engine in units of one hundred pounds rounded up to the next unit, e.g., for a packaged engine weighing 1,840 pounds, EWT = 19.

$MBRP_k$ = the validated average cost of repairing module k at intermediate level maintenance as a result of removals generated in the TLE validation test period. $MBRP_k$ shall include the cost of consumable material and shall be computed in a manner analogous to $EBRP_0$ above.

$MDRP_k$ = the validated average cost of repairing module k at depot level maintenance as a result of removals generated in the TLE validation test period. This cost shall include the cost of consumable material and shall be computed in a manner analogous to EDRP above.

Other symbols are as previously defined.

1.19 The next element of cost to be considered consists of the estimated dollars associated with the spare quantity of engines and modules which must be acquired to keep the depot pipeline and depot safety stock sufficiently stocked to meet established support objectives. This cost element shall be computed in accordance with the following formula:

$$TLE_{13} = (CP^{\#}) \left[\frac{(1-RR^{\#})\,(DP+D)(FFH)}{(CMRI^{\#})} \right] +$$

$$(m) \left[\frac{(FFH)(DP+D)}{CMRI^{\#}} \right] \sum_{k=1}^{NM} (MR_k^{\#}) \quad (UP_k^{\#}) \quad (1-RR_k^{\#})$$

The MLE analogue for this cost element is as follows:

$$MLE_{13} = (CP) \left[\frac{(1-RR)(DP+D)(FFH)}{(CMRI)} \right] +$$

$$(m) \left[\frac{(FFH)(DP+D)}{CMRI} \right] \sum_{k=1}^{NM} (MR_k) \quad (UP_k) \quad (1-RR_k)$$

where

DP = pipeline standard for depot maintenance for the A-10 engine and modules = 45 days.

D = the number of day's worth of depot safety stock for the A-10 engine and modules = 15 days.

Other symbols are as previously defined.